

# ***Interim Remedial Action Report for the OU 7-08 Organic Contamination in the Vadose Zone Project***

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*February 2003*



*Idaho National Engineering and Environmental Laboratory  
Bechtel BWXT Idaho, LLC*

**INEEL/EXT-02-00862  
Revision 0**

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**February 2003**

**Idaho National Engineering and Environmental Laboratory  
Environmental Restoration Program  
Idaho Falls, Idaho 83415**

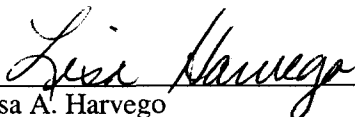
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**INEEL/EXT-02-00862  
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**February 2003**

Approved by

  
\_\_\_\_\_  
Lisa A. Harvego  
OU 7-08 Project Engineer

  
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Date

## ABSTRACT

This report is a description of the remedial action activities performed from July 1999 through December 2001 for Operable Unit 7-08 at the Idaho National Engineering and Environmental Laboratory. Operable Unit 7-08, organic contamination in the vadose zone, extends from the land surface to the top of the Snake River Plain Aquifer approximately 177 m (580 ft) beneath the Radioactive Waste Management Complex excluding the Subsurface Disposal Area disposal pits and trenches. The vadose zone contains volatile organic compounds primarily in the form of organic vapors that have migrated from buried waste in the Subsurface Disposal Area pits.

Operable Unit 7-08 is the designation recognized under the *Federal Facility Agreement and the Consent Order* (DOE-ID 1991) and the Comprehensive Environmental Response Compensation and Liability Act (42 USC § 9601 et seq., 1980) for organic contamination in the vadose zone remediation beneath and in the vicinity of the Radioactive Waste Management Complex. The remediation is being performed in accordance with the Operable Unit 7-08 Record of Decision signed in 1994 (DOE-ID 1994). The objective of the remedial action, as stated in the Operable Unit 7-08 Record of Decision, is to reduce the risks to human health and the environment associated with the organic contaminants present in the vadose zone and to prevent federal and state safe drinking water standards from being exceeded in the future.

The first phase of remedial action is documented in the *Final Phase I Remedial Action Report for Organic Contamination in the Vadose Zone Operable Unit 7-08* (Higgins 1997). Remediation activities completed between the start of Phase II in January 1998 and July 1999 are documented in the *Interim Phase II Remedial Action Report for Organic Contamination in the Vadose Zone Operable Unit 7-08* (INEEL 1999). This interim remedial action report documents remedial action activities conducted between July 1999 and December 2001.



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## ACRONYMS

CCl <sub>4</sub>	carbon tetrachloride
CHCL <sub>3</sub>	chloroform
Cl	chlorine
DOE	U.S. Department of Energy
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
FY	fiscal year
HDT	historical data task
IDEQ	Idaho Department of Environmental Quality
INEEL	Idaho National Engineering and Environmental Laboratory
IRA	interim risk assessment
OCVZ	organic contamination in the vadose zone
OU	operable unit
PCE	tetrachloroethene
RA	remedial action
RD/RA	remedial design/remedial action
RI/FS	remedial investigation and feasibility study
ROD	Record of Decision
RWMC	Radioactive Waste Management Complex
SAIC	Science Applications International Corporation
SDA	Subsurface Disposal Area
STAR	Shield Test Air Reactor
TCA	1,1,1-trichloroethane
TCE	trichloroethene
VOC	volatile organic compound
VVET	vapor vacuum extraction with treatment



# Interim Remedial Action Report for the OU 7-08 Organic Contamination in the Vadose Zone Project

## 1 INTRODUCTION

### 1.1 Purpose

The *Remedial Investigation/Feasibility Study* (RI/FS) (Duncan, Troutman, and Sondrup 1993) was completed to identify the physical characteristics of the site, to provide a summary of the contaminants present in various media at the site, and to identify current risk factors. Four alternatives for remediation of the site were examined.

The RI/FS (Duncan, Troutman, and Sondrup 1993) investigated the subsurface strata at the Subsurface Disposal Area (SDA) and characterized the sequence of fractured basalt and sediments. The Snake River Plain Aquifer is present at a depth of approximately 580 ft beneath the Radioactive Waste Management Complex (RWMC). Elevated concentrations of  $\text{CCl}_4$  were detected above several of the pits, indicating that volatile organic compounds (VOCs) had migrated in the vapor phase from the source pits into shallow soils at the SDA. The rate of vapor discharge to the atmosphere was measured using a surface flux chamber. Vapor port monitoring wells were used to characterize the nature and extent of contamination in the vadose zone. Data from vapor port monitoring indicated that contamination had migrated laterally as far as 3,000 ft beyond the SDA boundary.

Site risks including human health and environmental concerns were evaluated. It was determined that releases from the site present an imminent risk to public health, welfare, or the environment.

Remedial alternatives were developed and analyzed in detail to evaluate their protectiveness of human health and the environment. The primary objective was to prevent vapor phase contaminants in the vadose zone from reaching the groundwater in concentrations that would result in future concentrations that exceed maximum contaminant levels.

The four alternatives evaluated included: (1) no action, (2) containment by capping, (3) extraction/treatment by vapor vacuum extraction, and (4) extraction/treatment by vapor vacuum extraction with vaporization enhancement. A comparative analysis of the alternatives was completed, and ultimately extraction/treatment was selected and deployed.

A treatability study was conducted at the SDA in 1993 to determine the effectiveness of the vapor vacuum extraction process in removal of contaminants from the vadose zone. This test indicated that the extraction system was effective in reducing contaminant concentrations in vapor monitoring wells as much as 450 ft from the extraction well.

The remedial action (RA) activities performed from July 1999 through December 2001 for Operable Unit (OU) 7-08 at the Idaho National Engineering and Environmental Laboratory (INEEL) are described in this *Interim Remedial Action Report* in accordance with the *Federal Facility Agreement and Consent Order* (DOE-ID 1991).

Operable Unit 7-08, organic contamination in the vadose zone (OCVZ), extends from the land surface to the top of the Snake River Plain Aquifer approximately 177 m (580 ft) beneath the RWMC excluding the SDA

disposal pits and trenches. The vadose zone contains VOCs, primarily in the form of organic vapors, that have migrated from the buried waste in the SDA pits.

Operable Unit 7-08 is the designation recognized under the *Federal Facility Agreement and Consent Order* (DOE-ID 1991) and the Comprehensive Environmental Response Compensation and Liability Act (42 USC § 9601 et seq., 1980) for OCVZ remediation beneath the RWMC. The remediation is being performed in accordance with the OU 7-08 Record of Decision (ROD) signed in 1994 (DOE-ID 1994).

The objective of the RA, as stated in the OU 7-08 ROD (DOE-ID 1994), is to reduce the risks to human health and the environment associated with the organic contaminants present in the vadose zone and to prevent federal and state safe drinking water standards from being exceeded in the future. As stated in the ROD (DOE-ID 1994), the remedy selected to accomplish this objective is vapor vacuum extraction with treatment (VVET). Vapor vacuum extraction with treatment extracts organic contaminants from the subsurface and subsequently destroys them at the surface by means of recuperative flameless thermal oxidation or catalytic processes.

On January 11, 1996, Units A, B, and C were started, and Phase I of remediation of OCVZ began. Originally, extraction was to be conducted in three 2-year phases. The intent was to operate the system for 2 years, evaluate the performance of the system, and make modifications and improvements as necessary. Phase I lasted 2 years according to the original schedule from January 1996 through January 1998. Phase II, currently projected to end no later than 2014, began in January 1998 and will continue until active vapor extraction is no longer required to ensure that the remedial action objectives will be met. Phase III is scheduled to begin immediately after Phase II ends and will continue for at least 4 years, terminating as early as 2018. Though progress has been made in achieving cleanup goals, the original schedule appears to have been overly optimistic, necessitating an extension of Phases II and III. The primary reasons for the extensions are: (1) the VOC source areas may still be active and contributing mass to the vadose zone, (2) there may be a large reservoir of VOC mass in the subsurface material, or (3) a combination of 1 and 2. These are discussed in more detail later in this report.

The first phase of remedial action is documented in the *Final Phase I Remedial Action Report for Organic Contamination in the Vadose Zone Operable Unit 7-08* report (Higgins 1997). Remediation activities completed between the start of Phase II in January 1998 and July 1999 are documented in the *Interim Phase II Remedial Action Report for Organic Contamination in the Vadose Zone Operable Unit 7-08* (INEEL 1999). This report documents RA activities conducted between July 1999 and December 2001. The remediation activities are being performed in accordance with the OU 7-08 *Remedial Design/Remedial Action Work Plan* (Scientech 1995).

## 1.2 Background

The RWMC is located in the southwest portion of the INEEL and was established in 1952 as a disposal site for solid low-level radioactive waste generated by the INEEL and other U.S. Department of Energy (DOE) operations. It encompasses approximately 704,178 m<sup>2</sup> (174 acres) and consists of three main areas: (1) the SDA, (2) the Transuranic Storage Area, and (3) an administrative area. Figures 1-1 and 1-2 are maps showing the locations of the RWMC at the INEEL and the SDA within the RWMC, respectively.

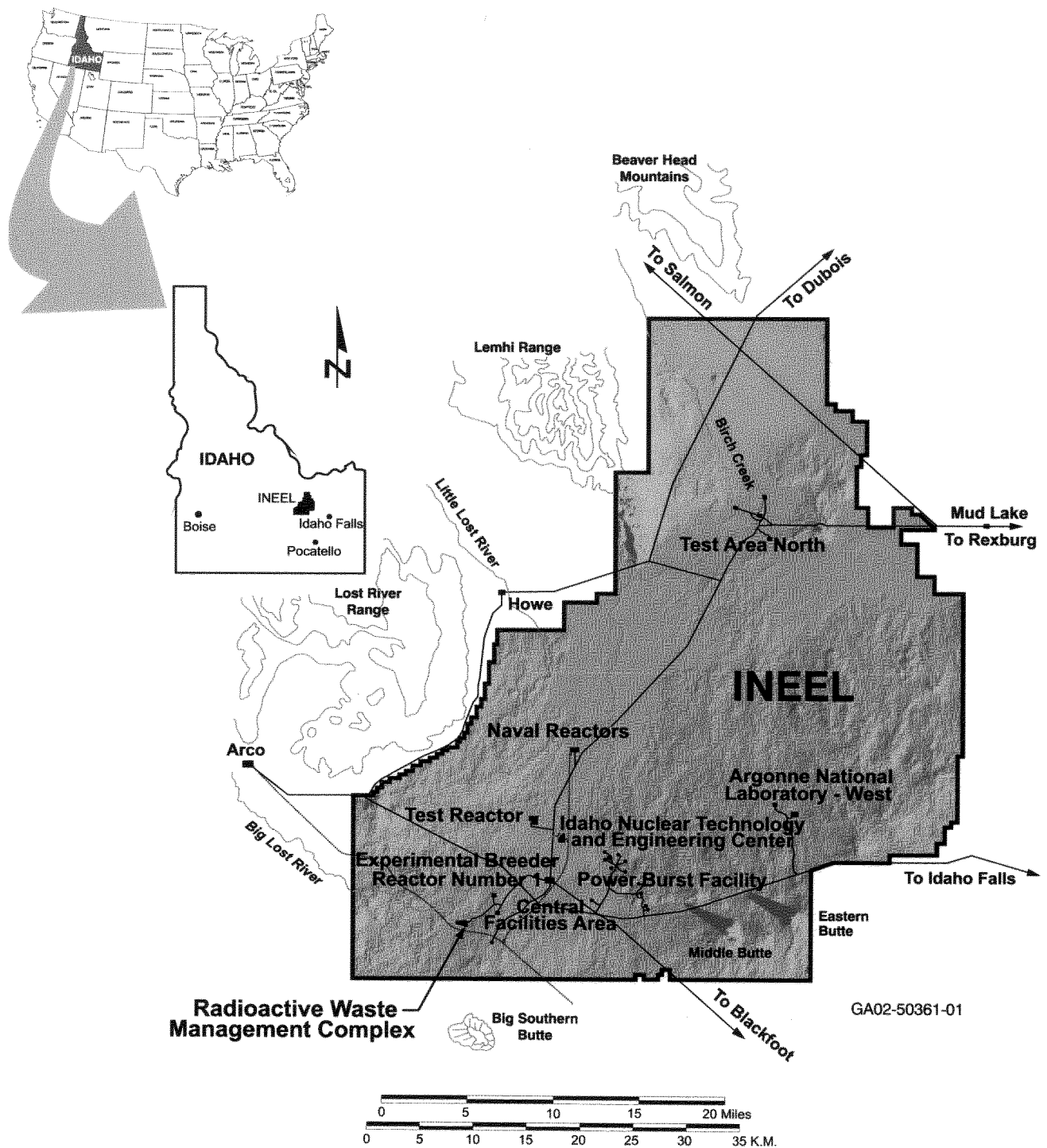


Figure 1-1. Map of the Idaho National Engineering and Environmental Laboratory Site showing the location of major facilities.



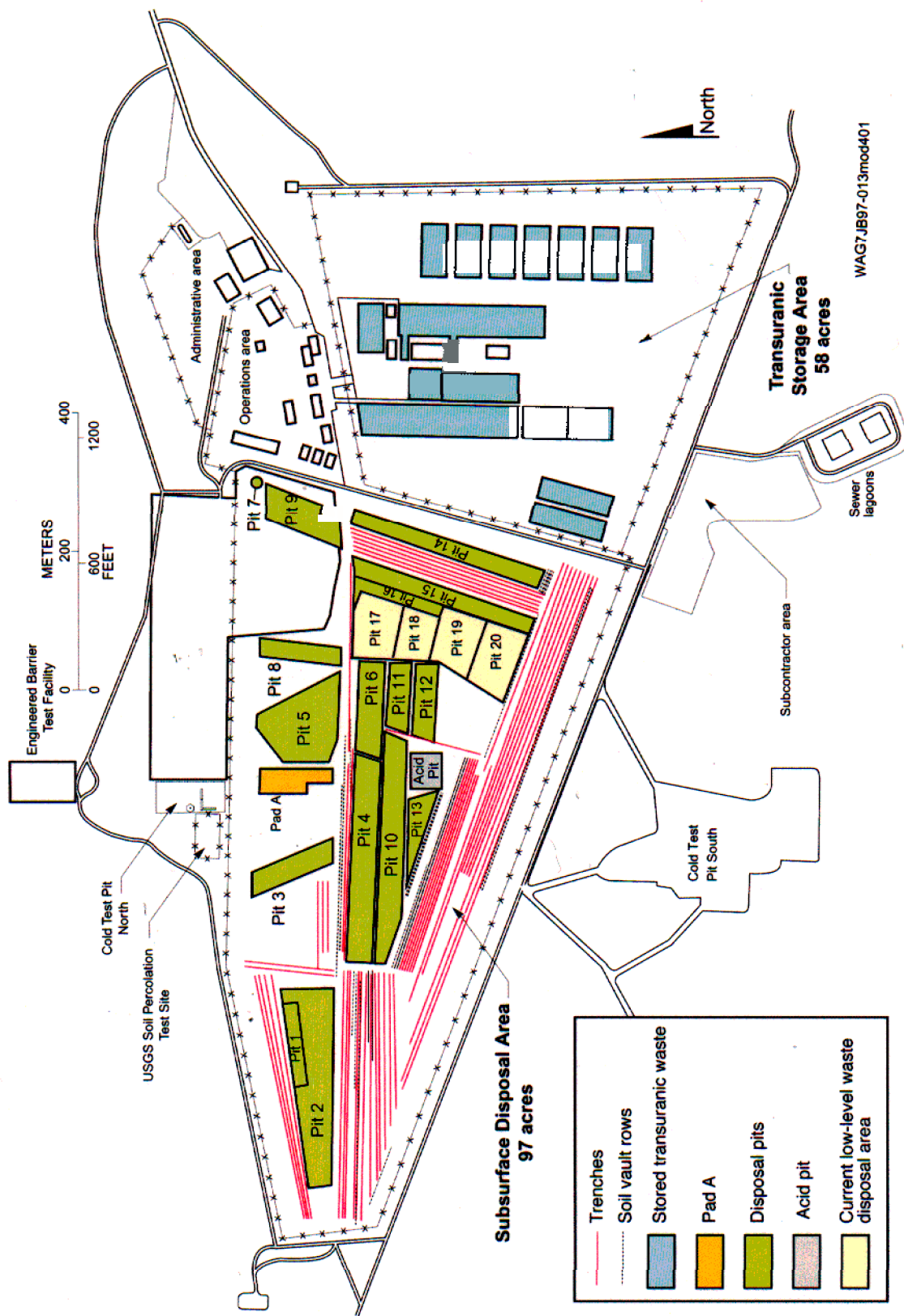


Figure 1-2. Map of the Radioactive Waste Management Complex showing the location of the Subsurface Disposal Area.

The SDA comprises individual storage and disposal areas consisting of pits, trenches, aboveground storage pads, and soil vaults. The presence of organic contaminants in the vadose zone beneath the RWMC resulted from the burial and subsequent breach of containerized organic waste, primarily from the Rocky Flats Plant,<sup>a</sup> in several of the pits and trenches. The organic waste was mixed with calcium silicate to reduce free liquids and form a very thick grease-like material, which was typically double bagged and placed in drums before disposal. In addition, small amounts of absorbent, such as Oil-Dri, were normally mixed with the waste to bind free liquids. The organic waste consisted of lathe coolant, used oils, and degreasing agents such as carbon tetrachloride (CCl<sub>4</sub>); 1,1,1-trichloroethane; trichloroethene (TCE); tetrachloroethene; hydraulic oil; gearbox oil; spindle oil; Freon; and Varsol (Clements 1982). The containers have deteriorated over time, allowing VOC contaminants to migrate into the vadose zone. The vadose zone has subsequently become contaminated with VOCs, and trace levels of carbon tetrachloride have been detected in the underlying Snake River Plain Aquifer.

To implement the selected remedy described in the OU 7-08 ROD (DOE-ID 1994), which was issued final on December 2, 1994, 15 new vapor extraction and monitoring wells were installed in or next to the SDA during 1994. In addition, one existing extraction well (i.e., 8901D) and five existing monitoring wells (i.e., D02, 8801, 8902, 9301, and 9302) were incorporated for extracting and monitoring VOC vapors. In 2000, Wells DE-1 and M17S were installed to provide additional monitoring. Wells 6E and 7E were installed in more strategic locations and provide added extraction capability at shallow depths.

### **1.3 Organization of the Interim Remedial Action Report**

The remaining sections of this report are organized as follows:

- Section 2—Remedial action activities are summarized
- Section 3—A synopsis of the work performed is provided, and the verification process is described
- Section 4—Certification is provided that the remedy is operational and functional
- Section 5—Evaluation of the vapor extraction and monitoring efforts are provided
- Section 6—The future operations strategy is discussed
- Section 7—Problems encountered and lessons learned are discussed
- Section 8—The costs for the Phase II remedial action are summarized
- Section 9— A schedule for continuation of the Phase II remedial action is presented
- Section 10—Enforceable milestones for the Phase II remedial action of VVET operations are listed
- Section 11—References used in report development are identified.

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a. The Rocky Flats Plant is located 26 km (16 mi) northwest of Denver. In the mid-1990s, it was renamed the Rocky Flats Environmental Technology Site. In the late 1990s, it was again renamed to its present name, the Rocky Flats Plant Closure Project.



## 2 REMEDIATION ACTIVITIES

The OCVZ remedial action consists of several activities, including site operation, sampling and analysis, and reporting. These activities are discussed in detail in the following sections.

### 2.1 Future Site Use and Cleanup Goals

The OU 7-08 RI/FS (Duncan, Troutman, and Sondrup 1993) indicates that the anticipated future use of the SDA site is unrestricted residential. As such, it is possible that homes may be built on and groundwater wells drilled in the immediate vicinity of the SDA following a 100-year institutional control period. If the site is to be developed for unrestricted residential use, air and water quality must be maintained at levels protective of human health for all potential exposure pathways. To achieve this protectiveness, the OCVZ remedial action objectives are structured around vadose zone VOC concentrations that will prevent VOC concentrations in the groundwater from exceeding maximum contaminant levels at the end of the 100-year institutional control period. Remedial action objectives also include preliminary remediation goals that are based on both risk and frequently used standards (i.e., applicable or relevant and appropriate requirements) and that are typically expressed as contaminant cleanup levels to be achieved. Preliminary remediation goals for the OU 7-08 remedial action, as identified in the ROD (DOE-ID 1994), are based on the results of fate and transport modeling. Preliminary remediation goals are currently being reevaluated to incorporate recently acquired information such as soil tortuosity, residual VOC mass, and the revised VOC source estimate. It is anticipated that remediation goals for each of the regions identified in the OCVZ *Data Quality Objective Report* (INEEL 2002) will be developed based on updated fate and transport modeling results.

### 2.2 Chronology of Events

Pursuant to the OU-7-08 ROD (DOE-ID 1994), procurement of three VVET systems was initiated in the spring of 1995. The *Remedial Design/Remedial Action Work Plan* (Scientech 1995) was finalized on October 3, 1995. Three VVET units (A, B, and C) were manufactured in Knoxville, Tennessee, by Thermatrix, Inc. The units were delivered to the INEEL on November 15, 1995, installed on gravel pads, and system operability testing was completed on January 5, 1996, for Units A and B and January 25, 1996, for Unit C.

Insulated and heated enclosures were constructed to protect sensitive components from freezing temperatures, blowing snow, and high winds. Construction of the enclosures was completed in April of 1997.

Operation of Unit C was terminated three times following tube failures. After the third failure in May 2000, the decision was made to decommission and replace Unit C. A catalytic oxidation system, Unit D, was manufactured in San Diego, California, by King Buck Technology and installed at the SDA in 2001. Construction was completed in July 2001 and Unit D began full-scale operation in March 2002. Additional information on the construction activities is included in the OCVZ semiannual data reports. A timeline of key events follows in Table 2-1.

Each system currently in operation has an operating capacity of 400–500 scfm. One King Buck and two Thermatrix oxidizers are currently installed and in operation at the SDA. Further detail of operating procedures, parameters, and maintenance are included in the *Operations and Maintenance Plan for OCVZ* (McMurtrey and Harvego 2001).

In addition to construction activities related to installation and operation of the VVET units, several wells have been installed, instrumented, and/or adapted for use in monitoring and extracting VOC contaminated vapors. These wells are shown in Table 2-2 in roughly the order they were installed or began to be used. Many of the wells were installed before the OU 7-08 ROD (DOE-ID 1994).

Table 2-1. Timeline of Site actions.

Action	Date
Signing of Record of Decision (DOE-ID 1994)	December 2, 1994
Approval of <i>RD/RA Work Plan</i> (Sciencetech 1995)	October 3, 1995
Oxidizer delivery	November 15, 1995
System operability testing initiation	December 8, 1995
Preoperations prefinal inspection	December 12, 1995
System operability testing completion	January 5, 1996
Preconstruction review checklist	January 9, 1996
Permission to start operations	January 10, 1996
Start of remedy	January 11, 1996
Unit A startup	January 11, 1996
Unit B startup	January 18, 1996
Unit C startup	January 26, 1996
Operations prefinal inspection	March 14, 1996
<i>Health and Safety Plan</i> , Rev. 2	May 20, 1996
Unit C transformer fire	July 27, 1996
Unit B blower failure	September 5, 1996
Unit A shutdown for transformer repair	October 2, 1996
Unit C restart	January 5, 1997
Unit A restart	January 6, 1997
Unit B restart	January 7, 1997
<i>Health and Safety Plan</i> , Rev. 3	February 12, 1997
VVET enclosure installation	April 1997
Unit C tube failure	October 22, 1997
Unit C tube failure	December 17, 1998
Unit B tube failure	January 13, 1999
Unit B restart	August 13, 1999
Unit C restart	September 2, 1999
<i>Health and Safety Plan</i> , Rev. 4	September 16, 1999

Table 2-1. (continued).

Action	Date
Unit B shutdown for vessel repair	May 19, 2000
Unit C failure/decommission	May 31, 2000
<i>Data Quality Objectives Report</i> (INEEL 2002)	August 24, 2000
<i>Field Sampling Plan of the OCVZ</i> (Wells 2000)	September 28, 2000
Unit D delivery to SAIC STAR center	November 9, 2000
Unit D destruction and removal efficiency performance testing	November 14, 2000
Unit D delivery to Subsurface Disposal Area	February 14, 2001
Unit B restart	April 26, 2001
<i>Health and Safety Plan</i> (Miller 2001)	May 3, 2001
Unit D integrated system operability testing	July 11, 2001
Unit D prefinal inspection	July 17, 2001
Permission to start Unit D operations	July 17, 2001
Start Unit D shakedown operations	July 18, 2001
<i>Operations and Maintenance Plan for OCVZ</i> , Rev. 0 (McMurtrey and Harvego 2001)	August 8, 2001
Unit D full-scale operation	March 4, 2002
OCVZ = organic contamination in the vadose zone RD/RA = remedial design/remedial action SAIC = Science Applications International Corporation STAR = Shield Test Air Reactor VVET = vapor vacuum extraction with treatment	

Table 2-2. Wells installed or used by OU 7-08 for monitoring and/or extraction.

Well Name	Well Type
77-1, 78-4, WWW-1, USGS-118	Existing wells adapted for use as vapor sampling wells
DO2, 8801, 8902	Vapor monitoring wells with permanent sampling ports
8901	Vapor extraction well
9301, 9302	Vapor monitoring wells with permanent sampling ports
VVE-1, VVE-3, VVE-4, VVE-6, VVE-7, VVE-10	Vapor monitoring wells with sampling ports
M1S, M3S, M4D, M6S, M7S, M10S	Groundwater monitoring wells with permanent vapor sampling ports
1E, 2E, 3E, 4E, 5E, 1V, 2V, 3V, 4V, 5V, 6V, 7V, 8V, 9V, 10V	Vapor extraction and monitoring wells

Table 2-2. (continued).

OCVZ-11, OCVZ-13, OCVZ-14	Vapor monitoring wells with permanent sampling ports
M11S, M13S, M14S, M15S, M16S, M17S	Groundwater monitoring wells with permanent vapor sampling ports
DE1	Vapor extraction and monitoring well
6E, 7E	Vapor extraction wells
SE3, SE4, SE6, SE7, SE8	Vapor extraction wells <sup>a</sup>
IE3, IE4, IE6, IE7, IE8, DE3, DE4, DE6, DE7, DE8	Vapor extraction and monitoring wells <sup>a</sup>

a. Installation currently being performed or imminent

## 2.3 Performance Standards and Construction Quality Control

The effectiveness of the OU 7-08 remedial action is measured primarily by VOC mass removal from the vadose zone and reduction in subsurface vapor concentrations. Section 5 provides an evaluation of vapor extraction and soil-vapor monitoring data. Cumulative mass removed since the beginning of operations as well as mass removed during a specific operating period is presented in semiannual data reports. The most recent semiannual data report, *OU 7-08 End-Year Data Report, 2001* (McMurtrey 2002), provides documentation that during the period from July 1, 2001, to December 31, 2001, the VVET units removed and treated approximately 5,317 kg (11,722 lb) of total VOCs, including 3,320 kg (7,319 lb) of carbon tetrachloride; 837 kg (1,845 lb) of trichloroethene; 151 kg (333 lb) of tetrachloroethene; 232 kg (511 lb) of 1,1,1-trichloroethane; and 777 kg (1,713 lb) of chloroform. Since the start of operations in January of 1996, approximately 47,280 kg (104,234 lb) of total VOCs have been removed and treated, including approximately 30,326 kg (66,857 lb) of carbon tetrachloride; 6,722 kg (14,819 lb) of trichloroethene; 1,551 kg (3,419 lb) of tetrachloroethene; 1,870 kg (4,123 lb) of 1,1,1-trichloroethane; and 6,811 kg (15,016) of chloroform.

The OU 7-08 remedial action treatment process has been designated with a safety category of consumer grade, and all components are procured as Quality Level 4. The QA/QC program used throughout the remedial action is outlined in the *Quality Assurance Project Plan* (DOE-ID 2002), *OCVZ Data Quality Objective Report* (INEEL 2002), and the *OCVZ Field Sampling Plan* (INEEL/EXT-99-00907).

## 2.4 Final Inspection and Certification

The prefinal inspection of the initial remedial action construction and operations was completed in March 1996. Details of the prefinal inspection of Unit A, B, and C installations is included in the *OCVZ Phase I Remedial Action Report for Organic Contamination in the Vadose Zone Operable Unit 7-08* (Higgins 1997).

DOE, Idaho Department of Environmental Quality (IDEQ), and U.S. Environmental Protection Agency (EPA) conducted the prefinal inspection for the OCVZ Unit D installation before full-scale operation began on July 17, 2001. All items on the checklist were completely closed in the spring of 2002

as documented in an April 17, 2002, correspondence from DOE to IDEQ and EPA. This correspondence and the Prefinal Inspection Checklist are included in Appendix B.

As of December 31, 2001, no health and safety problems have been encountered during construction or operation. The *HASP for OU 7-08* outlines the requirements used to eliminate or minimize health and safety risks to personnel working at the OU 7-08 treatment site (Miller 2001).

## 2.5 Site Operation

To implement the selected remedy described in the OU 7-08 ROD (DOE-ID 1994), three VVET units with recuperative flameless thermal oxidation were installed within the boundaries of the SDA and brought into full-scale operation in 1996. Two of the systems (designated as Units A and B) were designed to extract and treat vapors from two extraction wells each, and one system (designated as Unit C) was designed to extract and treat vapors from one extraction well. During the spring of 2001, Unit C was decommissioned and removed from the SDA and replaced with an electrically heated catalytic oxidizer (designated as Unit D) installed at the previous Unit C site. Currently, Unit A treats vapors from Extraction Well 8901D, Unit B treats vapors from Extraction Well 2E, and Unit D treats vapors from Extraction Well 7V. Block diagrams for the thermal and catalytic oxidizers are shown in Figures 2-1 and 2-2.

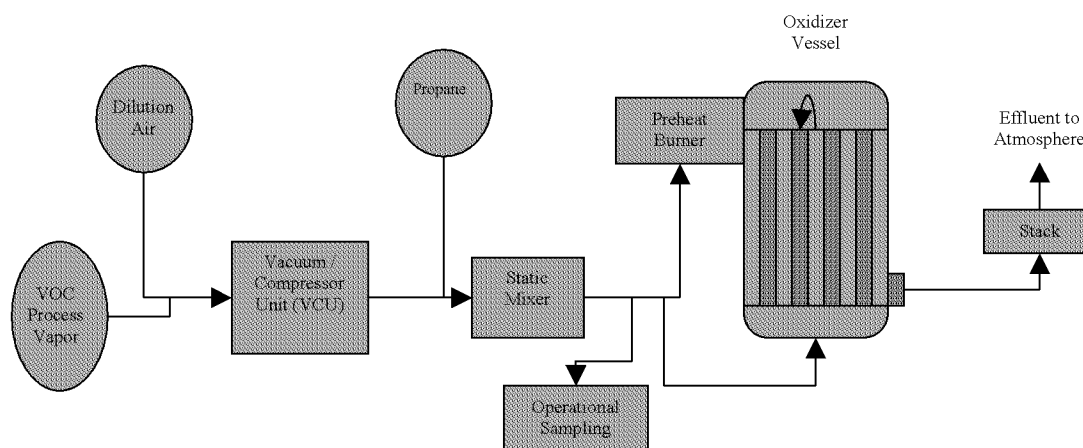


Figure 2-1. Block diagram of thermal oxidation system.



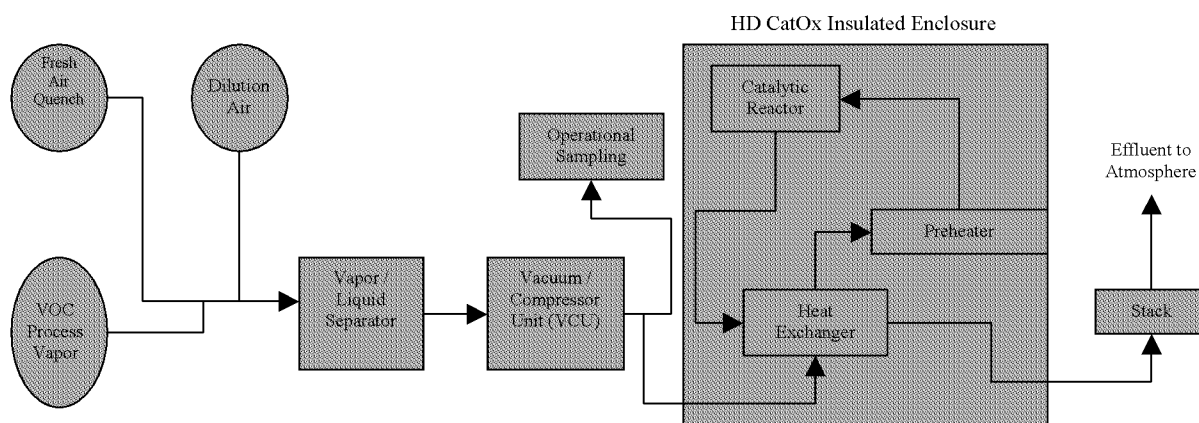


Figure 2-2. Block diagram of catalytic oxidation system.

Full-time system technicians and engineers maintain and monitor unit operations during the 4-day, 10-hour/day workweek. The technicians schedule and oversee routine maintenance, collect influent samples, complete operations logs and reports, and perform troubleshooting activities when necessary. Operations activities have also involved system modifications, upgrades, inspections, and procedure and work order development and revision.

Since startup of the VVET system in January 1996, the VVET units have operated for a combined total of 67,024 hours out of the 109,113 available operating hours through December 31, 2001 (McMurtrey 2002). The operating schedule is shown in Table 2-3. As of December 31, 2001, 47,280 kg (104,235 lb) of VOCs have been removed (Harvego 2002).

Table 2-3. Cumulative operating schedule of the vapor vacuum extraction with treatment system.

Operating Period	Year	Unit A	Unit B	Unit C	Unit D
First 8 weeks	1996				
Hours operated		1,321	1,137	1,102	
Hours available		1,602	1,437	1,265	
Percent operated		82%	79%	87%	
Second 8 weeks	1996				
Hours operated		916	614	915	
Hours available		994	971	994	
Percent operated		92%	63%	92%	
Third 8 weeks	1996				
Hours operated		750	640	752	
Hours available		1,008	864	1,056	
Percent operated		74%	74%	71%	
First quarter	1997				
Hours operated		120	744	1056	
Hours available		2,952	2,952	2,952	

Table 2-3. (continued).

Operating Period	Year	Unit A	Unit B	Unit C	Unit D
Percent operated		4%	25%	36%	
Second quarter	1997				
Hours operated		899	1,223	1,355	
Hours available		1,023	1,531	1,633	
Percent operated		88%	80%	83%	
Third quarter	1997				
Hours operated		824	764	898	
Hours available		954	817	912	
Percent operated		86%	94%	98%	
Fourth quarter	1997				
Hours operated		2,776	2,677	160	
Hours available		2,845	2,840	2,848	
Percent operated		98%	94%	6%	
Midyear	1998				
Hours operated		2,821	2,639	0	
Hours available		2,880	2,880	2,880	
Percent operated		98%	92%	0%	
End-year	1998				
Hours operated		3,809	3,713	0	
Hours available		4,200	4,152	4,104	
Percent operated		91%	90%	0%	
Midyear	1999				
Hours operated		3,162	305	0	
Hours available		4,152	407	4,152	
Percent operated		76%	75%	0%	
End-year	1999				
Hours operated		3,120	2,544	2,424	
Hours available		3,432	3,432	3,432	
Percent operated		91%	74%	71%	
Midyear	2000				
Hours operated		3,520	3,236	1,938	
Hours available		4,032	4,032	4,032	
Percent operated		87%	80%	48%	
End year	2000				
Hours operated		2,325	0	Unit C failed in spring 2000	
Hours available		3,144	3,144		
Percent operated		74%	0%		
Midyear	2001				
Hours operated		2,440	624		

Table 2-3. (continued).

Operating Period	Year	Unit A	Unit B	Unit C	Unit D
Hours available		4,008	4,008	Unit C replaced by Unit D in spring 2001	
Percent operated		61%	16%		
End-Year	2001				Unit D shakedown period
Hours operated		3,049	3,712		
Planned downtime		336	336		
Hours available		4,080	4,080		
Percent operated		75%	91%		
Total	1996 to 2001				
Hours operated		31,852	24,572	10,600	
Hours available		41,306	37,547	30,260	
Percent operated		77%	65%	35%	

## 2.6 Sampling and Analysis

Sampling and analysis activities are completed to support the OCVZ RA objectives. These activities include operational, environmental, and occupational sampling and analysis and are discussed in the following sections.

### 2.6.1 Operational Sampling

Samples are collected from the inlet of each of the VVET units and are analyzed using a Brüel and Kjaer Photoacoustic Gas Analyzer, Model 1302. The detected contaminant concentrations are used in conjunction with system flow rates and operational run time to estimate the cumulative VOC mass removal. Samples are collected and analyzed in accordance with the *Data Quality Objectives Summary Report for the Operable Unit 7-08 Post-Record of Decision Sampling* (INEEL 2002).

The analyte mass contribution to total VOC mass from all operational cycles through December 31, 2001, for the five analytes of concern, including chloroform; 1,1,1-trichloroethane; tetrachloroethene; trichloroethene; and carbon tetrachloride, identified in the *OCVZ Data Quality Objectives Report* (INEEL 2002) is depicted in Figure 2-3. The operational cycle dates, amount of each analyte removed, and the total VOCs removed each cycle are reported in the *Organic Contamination in the Vadose Zone Environmental and Operational End-Year Data Report, 2001* (McMurtrey 2002) and shown in Table 2-4. This report is updated semiannually. Reports published during December 1999–December 2001 are listed in Section 2.3.

### 2.6.2 Environmental Sampling

Data from representative monitoring well vapor samples are used to assess the effectiveness of the OCVZ remedy and to optimize OCVZ mass removal. Nineteen wells within and next to the SDA have been used for monitoring purposes during remedial action operations. Each well has from one to nine vapor ports (not all of which are sampled), ranging in depth from 9.9 to 174.7 m (32.5 to 573 ft) below land surface. The locations of wells and VVET systems are depicted in Figure 2-4 and vapor port depths are shown in Figure 5-3.

Samples are collected from 99 vapor ports within and in the immediate vicinity of the SDA boundary on a monthly basis. An additional 25 ports outside the SDA boundary are used to monitor the vapor concentrations at various locations ranging up to 2,774 m (9,100 ft) from the VOC source area at quarterly intervals. Vapor port sampling and analysis are completed in accordance with the *OCVZ Data Quality Objective Report* (INEEL 2002). Sampling precision, accuracy, completeness, and comparability are discussed in each of the individual operating cycle data reports. The results of the environmental sampling are published annually in a well monitoring, supplemental report (Housley 2002).

The results of the environmental sampling indicate that concentrations have decreased substantially within the remedial action zone of influence. The effectiveness of OCVZ operations is discussed in Section 5.

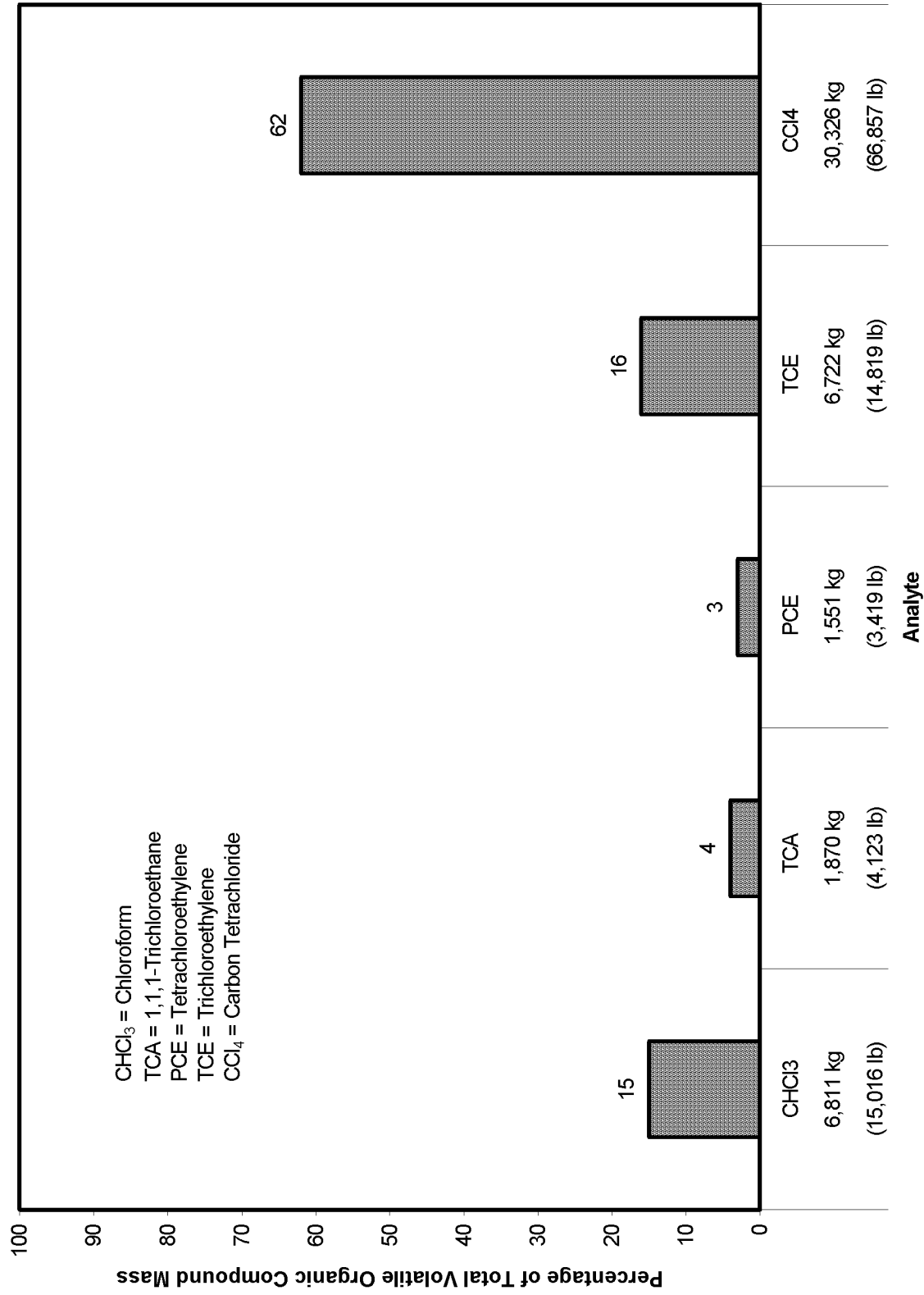


Figure 2-3. Analyte mass contribution to total volatile organic compound mass (total operating/shutdown cycles during 1996–2001).

Table 2-4. Breakdown by operating cycle of the mass of contaminant removed to date.

Operating Period	Year	CHCl <sub>3</sub> (kg)	TCA (kg)	PCE (kg)	TCE (kg)	CCl <sub>4</sub> (kg)	Total (kg)
First 8 weeks	1996	510	151	106	461	2,277	3,505
Percentage of total		15%	4%	3%	13%	65%	
Second 8 weeks	1996	258	80	64	247	1,203	1,853
Percentage of total		14%	4%	3%	13%	65%	
Third 8 weeks	1996	169	51	36	151	753	1,159
Percentage of total		15%	4%	3%	13%	65%	
First quarter	1997	196	48	28	142	857	1,270
Percentage of total		15%	4%	2%	11%	67%	
Second quarter	1997	497	165	134	494	2,393	3,684
Percentage of total		13%	4%	4%	13%	65%	
Third quarter	1997	291	54	65	273	1,266	1,949
Percentage of total		15%	3%	3%	14%	65%	
Fourth quarter	1997	547	155	110	449	2,452	3,713
Percentage of total		15%	4%	3%	12%	66%	
Midyear	1998	489	153	112	436	2,147	3,337
Percentage of total		15%	5%	3%	13%	64%	
End-year	1998	674	175	191	714	2,768	4,523
Percentage of total		15%	4%	4%	16%	61%	
Midyear	1999	378	98	74	404	1,860	2,814
Percentage of total		13%	4%	3%	14%	66%	
End-year	1999	514	178	163	637	2,490	3,982
Percentage of total		13%	4%	4%	16%	63%	
Midyear	2000	528	149	139	608	2,414	3,838
Percentage of total		14%	4%	4%	16%	63%	
End-year	2000	286	58	31	257	1,331	1,964
Percentage of total		14%	3%	2%	13%	68%	
Midyear	2001	697	123	147	612	2,795	4,374
Percentage of total		16%	3%	3%	14%	64%	
End-year	2001	777	232	151	837	3,320	5,317

Table 2-4. (continued).

Operating Period	Year	CHCl <sub>3</sub> (kg)	TCA (kg)	PCE (kg)	TCE (kg)	CCl <sub>4</sub> (kg)	Total (kg)
Percentage of total		15%	4%	3%	16%	62%	
Total	1996 through 2001	6,811	1,870	1,551	6,722	30,326	47,280
Percentage of total		14%	4%	3%	14%	64%	
CCl <sub>4</sub> = carbon tetrachloride							
CHCl <sub>3</sub> = chloroform							
PCE = tetrachloroethene							
TCA = 1,1,1-trichloroethane							
TCE = trichloroethene							

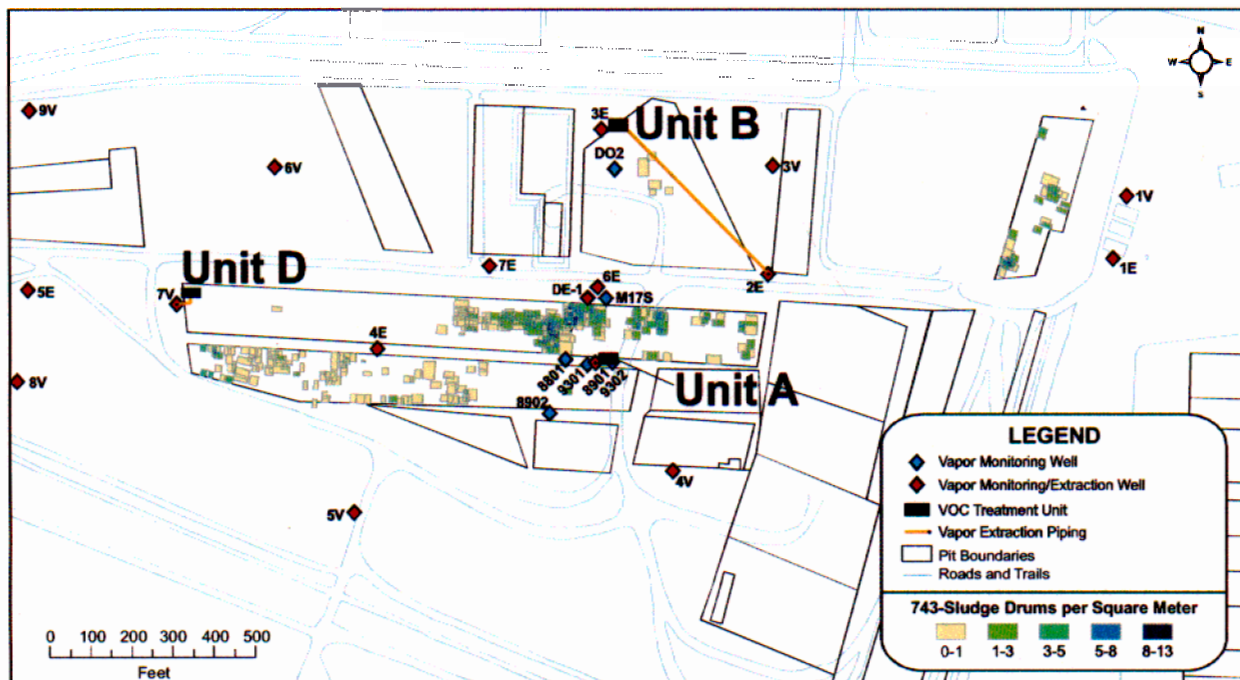


Figure 2-4. Vapor vacuum extraction with treatment system, extraction, and monitoring well locations.

### 2.6.3 Occupational Sampling

Two methods were used to monitor worker exposure to hazardous chemicals. Included in these were open path Fourier transform infrared spectrometry and active sampling area monitoring. Monitoring was conducted at various locations in the SDA as described in the following sections.

**2.6.3.1 Open Path Fourier Transform Infrared Spectrometry.** Air monitoring using open path Fourier transform infrared spectrometry was completed during 1999, 2000, and 2001 to determine the impact on air quality from operating the three VVET units located in the SDA. Two open path Fourier transform infrared spectrometers were deployed during the 1999, 2000, and 2001 field seasons at three locations in the prevailing downwind direction of the VVET units. The two open path units were rotated through the three sampling locations at prescribed intervals as shown in Table 2-5. It is important to note that the open path Fourier transform infrared spectrometers were calibrated by the manufacturer but outside of an ANSI-Z540-1-certified calibration program. The monitoring results and analysis of data collected using the open path Fourier transform spectrometers are reported in the *Air Monitoring Results of the Subsurface Disposal Area at the Radioactive Waste Management Complex for Operable Unit 7-08 Organic Contamination in the Vadose Zone 2001 Supplement* (Harvego 2002). Additional monitoring is planned to support future project and regulatory decisions involving emissions.



Table 2-5. Open path Fourier transform infrared spectrometry deployment schedule.

Open Path Fourier Transform Infrared Unit	Dates	Monitoring Location	Path Length (m)
Unit 1	6/21/00 to 7/27/00	Unit C	195
Unit 2	5/10/00 to 8/21/00	Unit A	210
Unit 2	8/21/00 to 10/31/00	Unit B	180
Unit 1	8/21/01 to 9/29/01	Unit A	190
Unit 1	9/29/01 to 11/1/01	Unit B	180
Unit 2	8/21/01 to 11/1/01	Unit D (replaced Unit C in 2001)	200

This report provides the measured concentrations of ten target off-gas compounds, eight VOCs, and two volatile inorganic compounds (hydrochloric acid and carbon monoxide). Target compounds are listed below:

- 1,1,1-trichloroethane
- Carbon monoxide
- Carbon tetrachloride
- Chloroform
- Freon 113
- Hydrochloric acid
- Methane
- Methylene chloride
- Propane
- Trichloroethene.

This report also provides a summary of monitoring activities completed during the 2000 and 2001 field seasons, including deployment schedule, generalized monitoring procedures, and data analysis. The report also provides interpretation of trends in the data, draws conclusions, and makes recommendations for future air monitoring.

A comparison of detected instantaneous compound concentrations to industrial hygiene exposure limits showed that in all cases, contaminant concentrations were well below any 8-hour, time-weighted, average exposure limit. The observed maximum target compound concentrations and the associated exposure limits are detailed in Table 2-6.

Table 2-6. Maximum detected target compound concentrations and exposure limits.

Target Compound	8-Hour Exposure Limit	Maximum Instantaneous Concentration <sup>d</sup>
1,1,1-trichloroethane	350 ppmv <sup>a,b</sup>	0.29 ppmv
Carbon monoxide	25 ppmv <sup>a</sup>	0.33 ppmv
Carbon tetrachloride	5 ppmv <sup>a</sup>	0.13 ppmv
Chloroform	10 ppmv <sup>a</sup>	0.24 ppmv
Freon 113	1,000 ppmv <sup>a,b</sup>	0.16 ppmv
Hydrogen chloride	5 ppmv <sup>c</sup>	0.10 ppmv
Methane	N/A	0.44 ppmv
Methylene chloride	25 ppmv <sup>b</sup>	0.59 ppmv
Propane	1,000 ppmv <sup>b</sup>	0.10 ppmv
Trichloroethene	50 ppmv <sup>a</sup>	0.20 ppmv

a. The value shown was obtained from ACGIH (2001).

b. The value shown was obtained from the Occupational Safety and Health Standards for General Industry (29 CFR 1910, 2002).

c. The value shown represents the ceiling limit for this compound.

d. Data was collected with instruments not calibrated under a program conforming to ANSI Z540.7. This data should be considered survey quality and preliminary in nature.

**2.6.3.2 Industrial Hygiene Sampling.** Industrial Hygiene sampling took place in the OCVZ VVET Unit A and B enclosures on August 28, 2001, and August 29, 2001, respectively. The Unit D enclosure was not sampled because it was out of service at the time. All samples were taken using active sampling pumps and covered a full-day sample period. Airborne contaminants sampled using National Institute for Occupational Safety and Health analysis methods included chlorine gas (NIOSH Method 6011), hydrochloric acid (NIOSH Method 7903), TCE (NIOSH Method 1003), chloroform (NIOSH Method 1003), and carbon tetrachloride (NIOSH Method 1003). The doors on the Unit A enclosure were both closed during the initial part of the sampling in an effort to create a worst-case scenario environment. By noon, the temperature had risen considerably inside the unit enclosure, and one door was propped open. Samples in the Unit B enclosure were taken with one door open and one door closed for the entire sample period. Schneider Laboratories, Inc., performed the analyses. The normal operating configuration for each of the enclosures is with the skirting on and the personnel access doors closed. However, personnel access doors are often left open during the summer months to allow air to circulate through and cool the enclosures. From an industrial-hygiene standpoint, the enclosures with closed doors present a worst-case scenario.

Industrial Hygiene area sampling was conducted in the OCVZ VVET Unit A and D enclosures on February 11, 2002. Airborne contaminants sampled again included chlorine gas, hydrochloric acid, TCE, chloroform, and carbon tetrachloride. As before, sampling was performed using NIOSH analytical method numbers 6011 and 7903 for chlorine gas and hydrochloric acid, respectively. The organic samples

were taken using SKC 575 Series Passive Samplers for Organic Vapors. Chlorine gas and hydrochloric acid were sampled over 385 minutes. The organic series was sampled over 23 hours (1,380 minutes). The doors were closed on both enclosures during the entire sampling period. Table 2-7 provides the sampling results.

Table 2-7. Industrial hygiene sampling results.

Analyte	Actual Exposure (ppmv)	Report Limit (ppmv) <sup>a</sup>
Unit A August 28, 2001		
Chlorine	<0.004	0.005
Hydrochloric acid	<0.008	0.005
Tetrachloroethene	<0.015	0.041
Chloroform	<0.020	0.040
Carbon tetrachloride	0.050	0.040
Unit B August 29, 2001		
Chlorine	<0.004	0.005
Hydrochloric acid	<0.009	0.005
Tetrachloroethene	<0.014	0.041
Chloroform	<0.019	0.040
Carbon tetrachloride	<0.015	0.040
Unit D February 11, 2002		
Chlorine	<0.005	0.5, C1
Hydrochloric acid	<0.05	C5
Trichloroethene	<0.50	50
Chloroform	<0.58	10
Methylene chloride	<0.85	25
Carbon tetrachloride	<0.45	5
Unit A February 11, 2002		
Chlorine	<0.005	0.5, C1
Hydrochloric acid	<0.05	C5
Trichloroethene	<0.50	50
Chloroform	0.91	10
Methylene chloride	<0.85	25
Carbon tetrachloride	3.20	5
a. Most conservative limit is listed. C = ceiling values Cl = chlorine		

Two analytes were found above the respective limits of detection: chloroform and carbon tetrachloride were both in the Unit A enclosure sample. The chloroform detection was very low and does not pose a health concern to the OCVZ VVET employees. The carbon tetrachloride results showed a 23-

hour average of 3.2 ppmv in the second set of samples, approaching the 5-ppmv-threshold limit value. Because this is a full 23-hour average air sample, it is not indicative of actual employee exposure.

In initial industrial hygiene sampling (August 28, 2001), the highest carbon tetrachloride concentration was 0.05 ppmv, 1/64 the concentration of the latest sample, 3.2 ppmv (February 11, 2002). The initial sample was collected with one Unit A door propped open and with no skirting installed. The latest sample was collected with the doors closed and skirting installed. This may explain the variation in sample results. Future industrial hygiene sampling and monitoring will focus on the carbon tetrachloride concentrations inside Unit A to verify the results of the past two samplings.

## 2.7 Reporting

Reporting of the sampling and analysis results during July 1999–December 2001 are presented in semiannual data reports, air-emissions monitoring reports, and well-vapor monitoring reports.

The *Volatile Organic Compound Vapor Monitoring Results from Selected Wells at the Radioactive Waste Management Complex, Supplement 2001* (Housley 2002) documents the VOC concentrations of vapor samples collected as early as May 1993 through calendar year 2001. This report is updated annually.

The *Air Monitoring Results of the Subsurface Disposal Area at the Radioactive Waste Management Complex, Supplement 2001* (Harvego 2002) documents the air monitoring results from 1999 through 2001 using open path Fourier transform infrared spectrometry.

Operational and sample data for OCVZ are documented in the semiannual data reports. Below is a brief discussion of each of the semiannual data reports prepared during July 1999–December 2001.

The end-year operating/shutdown cycle of 1999 began on July 26, 1999, and continued through December 31, 1999. The *Organic Contamination in the Vadose Zone Environmental and Operational End-Year Data Report, 1999* (Rodriguez 2000a) provides details of this reporting period.

The midyear operating/shutdown cycle of 2000 began on January 1, 2000, and continued through June 30, 2000. Details of this reporting period are collected in the *Organic Contamination in the Vadose Zone Environmental and Operational Mid-Year Data Report 2000* (Rodriguez 2000b). Operation of the VVET units was suspended from June 19, 2000, through August 21, 2000, to allow for planned maintenance and system upgrades and to facilitate VOC concentration rebound. VVET Unit C encountered a catastrophic failure and shut down for the final time on May 31, 2001.

The end-year operating/shutdown cycle of 2000 began on July 1, 2000, and continued through December 31, 2000. Details of this reporting period are contained in the *Organic Contamination in the Vadose Zone Environmental and Operational Data Report, Year-End Operating/Shutdown Cycle 2000* (McMurtrey 2001a). The rebound period commenced during the midyear 2000 reporting period and was terminated during the end-year 2000 reporting period. When Unit C failed, VVET Unit D was procured to replace the failed Unit C.

The midyear operating/shutdown cycle of 2001 began on January 1, 2001, and continued through June 30, 2001. Details of this reporting period are collected in the *Organic Contamination in the Vadose Zone Environmental and Operational Mid-Year Data Report* (McMurtrey 2001b). During this period, VVET Unit C was removed from the SDA and VVET Unit D was installed at the former Unit C location.

The end-year operating/shutdown cycle of 2001 began on July 1, 2001, and continued through December 31, 2001. The *Organic Contamination in the Vadose Zone Environmental and Operational End-Year Data Report, 2001* (McMurtrey 2002) provides details of this reporting period. The installation of VVET Unit D, operability testing, and the accompanying prefinal inspection by the agencies was completed during end-year 2001 reporting period. On July 18, 2001, VVET Unit D was brought into full-scale operation and began extracting vapors from the vadose zone. The shakedown phase of operations (McMurtrey 2002) for VVET Unit D continued through the end-year operations period.

## **2.8 Modifications to the Remedial Action**

The following modifications were made to the VVET system operations and monitoring activities during July 1999 through December 2001. The decision to perform these modifications was based on unit operations data, best management practice, and project management and the agency direction. These modifications listed below include changes to the original VVET system design, construction, and operation as specified in the *Remedial Design/Remedial Action Work Plan* (Sciencetech 1995):

- Unit C, a thermal oxidizer, was decommissioned and replaced with Unit D, a catalytic oxidizer
- High-temperature damage to the upper shell section of Unit B was repaired
- The project team has been reorganized and consolidated under Bechtel BWXT Idaho, LLC, to include a project manager, system engineer, field lead, operating technicians, and support engineers
- Operating procedures for the Thermatrix (thermal) oxidizers were revised, and new procedures for the King Buck catalytic oxidizer were developed
- The INEEL configuration management database was updated to provide quick access to information pertinent to repair or replacement of components installed on each of the VVET units
- A preventive maintenance schedule, conforming to the RWMC STD-101 (2002) work control process, was developed and implemented to ensure that appropriate measures are taken to maximize the lifetime of system components
- A calibration program was initiated to ensure proper function of process indicators
- Modulating butterfly valves and flow restriction orifices on the intake lines of Units A and B were replaced with linear control valves to improve process flow control
- Units A and B were reconfigured to eliminate failed uninterruptible power supplies
- Skirting and awnings were added to the VVET system enclosures to reduce heat loss, stabilize temperature variations in the structures, and minimize ice buildup in the entrances
- The *Operations and Maintenance Plan for OCVZ* (McMurtrey and Harvego 2001) was rewritten to include current operating procedures for each oxidizer type, a preventive maintenance schedule, technician training plan, and selected system drawings
- The *Field Sampling Plan for Operations and Monitoring* (Wells 2000) was written to implement the sampling requirements defined in the OCVZ data quality objective (DQO) process (INEEL 2002)

- The *Health and Safety Plan for VVET OCVZ* (Miller and Varvel 2001) was revised to establish current procedures and requirements used to eliminate or minimize health and safety risks to the personnel working at the OCVZ operation
- The OCVZ DQO report (INEEL 2002) was revised, incorporating ideas from the agencies on sampling intervals of vapor ports, formalizing goals for instrument accuracy and precision, establishing criteria for termination of active vapor extraction, and identifying requirements for long-term monitoring
- Well 7V was disconnected from Unit A, reconnected to Unit C, and ultimately connected to Unit D
- A prioritized list was developed for extending the OCVZ extraction well field, and efforts are underway to drill the first of the wells.



### **3 SYNOPSIS AND VERIFICATION OF WORK PERFORMED**

This section provides a synopsis of the VVET operation and identifies the documentation that verifies performance of the remedial action activities.

#### **3.1 Synopsis of Remedial Action Activities**

Phase II remedial action operations have continued since January 1998, the end-date of the *Phase I Remedial Action Report* (Higgins 1998). To date, Units A and B remain operational. Unit B went down for a period of approximately 7 months (January–August) in 1999 as a result of failure of the oxidizer tubes and was again taken out of service for approximately 5 months (August–December) for repair of high-temperature damage to the oxidizer shell. Unit B was rebuilt, restarted, and has been operational since April 2001. Unit C went down on September 11, 1997, because of sustained high-temperature operation and improper assembly of the unit by the manufacturer. Unit C was rebuilt but subsequently failed again on December 17, 1998, because of excessive propane feed. Unit C failed and shut down a final time on May 31, 2000, because of a system design flaw leading to damage of the oxidizer feed tubes. Unit C has been decommissioned and replaced with Unit D. Installation and testing was completed on Unit D, and the system has been in full-scale operation since January 2002.

#### **3.2 Verification of Work Performed**

Operating logs are completed daily by the VVET technicians. Data recorded in the logs include operating parameters for each VVET unit, maintenance activities, propane deliveries, and inspections.

Data reports documenting the operational and sample data are prepared semiannually. These reports are referred to as the midyear and end-year data reports. The reports include analysis of data quality, sampling performance, limited interpretation of sampling data, operational uptime, summary of operations and project activities, pertinent project specific lessons learned, and VOC mass removal estimates.





## 4 OPERATIONAL AND FUNCTIONAL REMEDY CERTIFICATION

Pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act regulations, “[a] remedy becomes operational and functional either one year after construction is complete, or when the remedy is determined concurrently by EPA and the IDEQ to be functioning properly and is performing as designed, whichever is earlier” (40 CFR 300.435 (f)(2), 2002). The OU 7-08 remedy was reported to be operational and functional in September of 1997 as part of the *Phase I Remedial Action Report for Organic Contamination in the Vadose Zone Operable Unit 7-08* (Higgins 1997) and continues to be operational through this interim reporting period. Unit D, a catalytic oxidizer, replaced Unit C, a thermal oxidizer, in 2001. A 6-week continuous operations period for Unit D was completed and the DOE, the EPA, and the IDEQ completed prefinal inspection of the catalytic oxidizer (see Appendix B). The DOE, EPA, and IDEQ determined that the system was functioning properly and performing as designed. The remedial action is effective at reducing the volatile organic contaminant concentrations in the vadose zone, and the areal extent of the contaminant plume has decreased since the beginning of remedial action operations. The carbon tetrachloride concentration in the vapor plume has been reduced by an order of magnitude at most sampling locations.

